كنترل فرآيند

SPC

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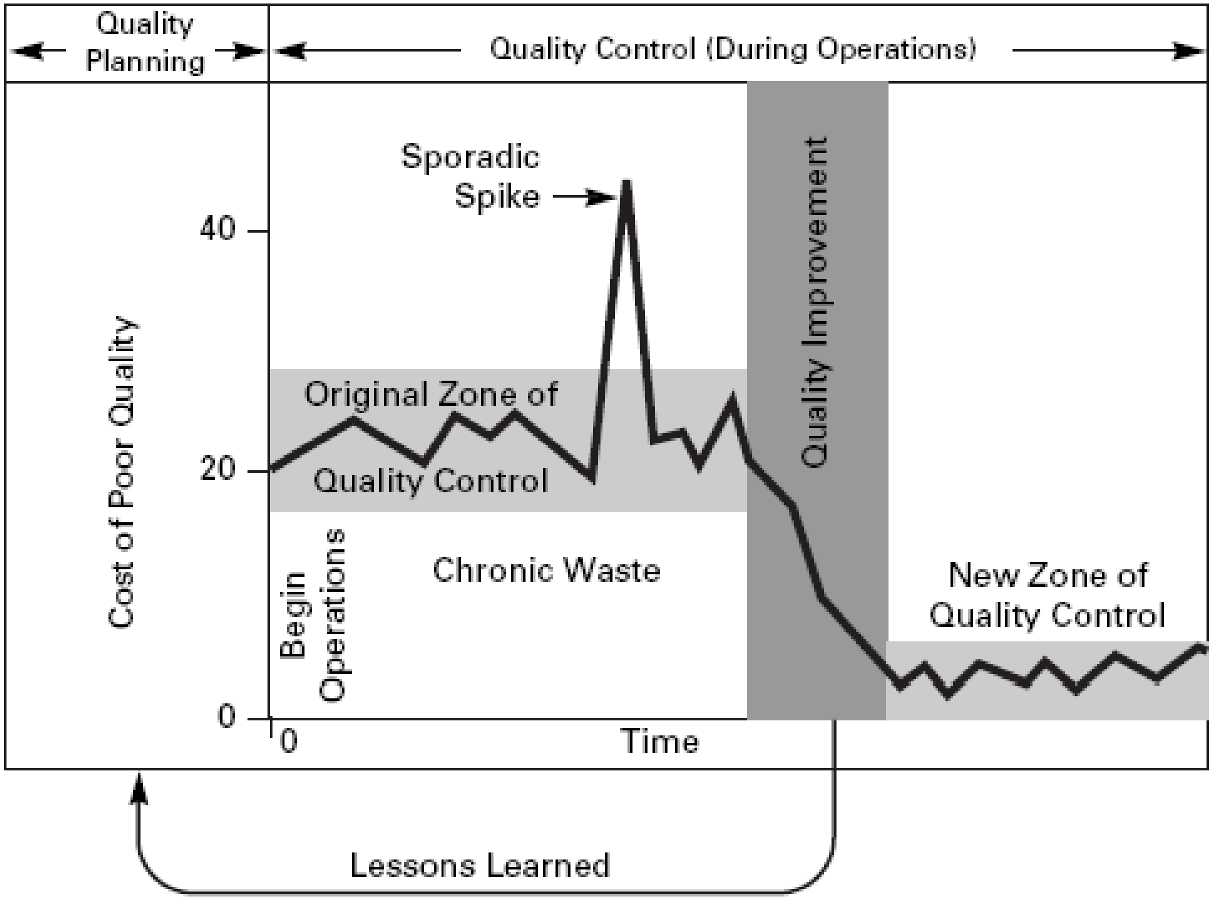

FIGURE 4.1 The Juran trilogy diagram. (*Juran Institute, Inc., Wilton, CT.*)

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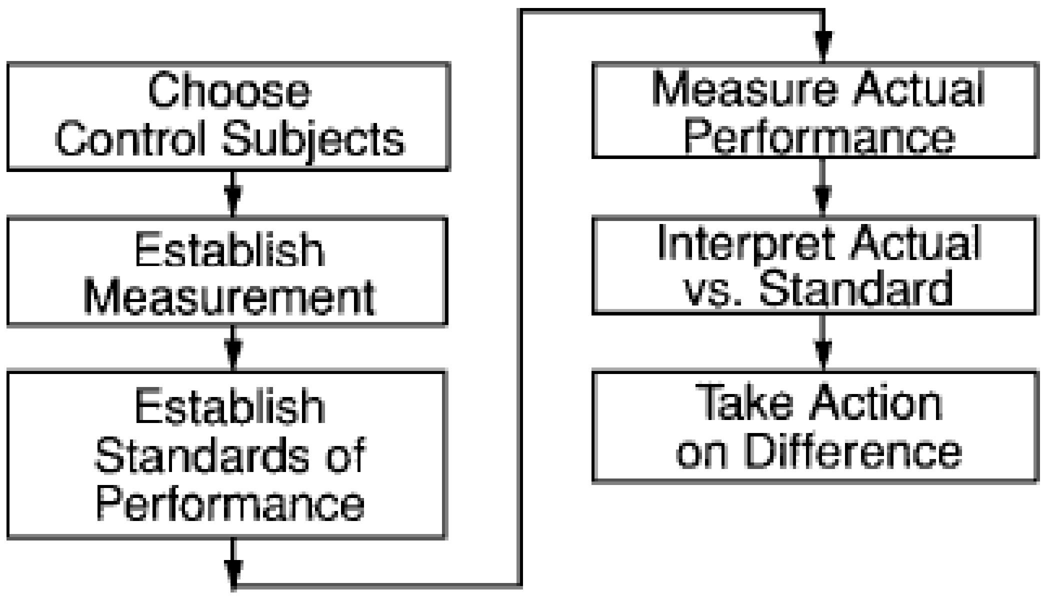

FIGURE 4.2 The input-output diagram for the quality control process.

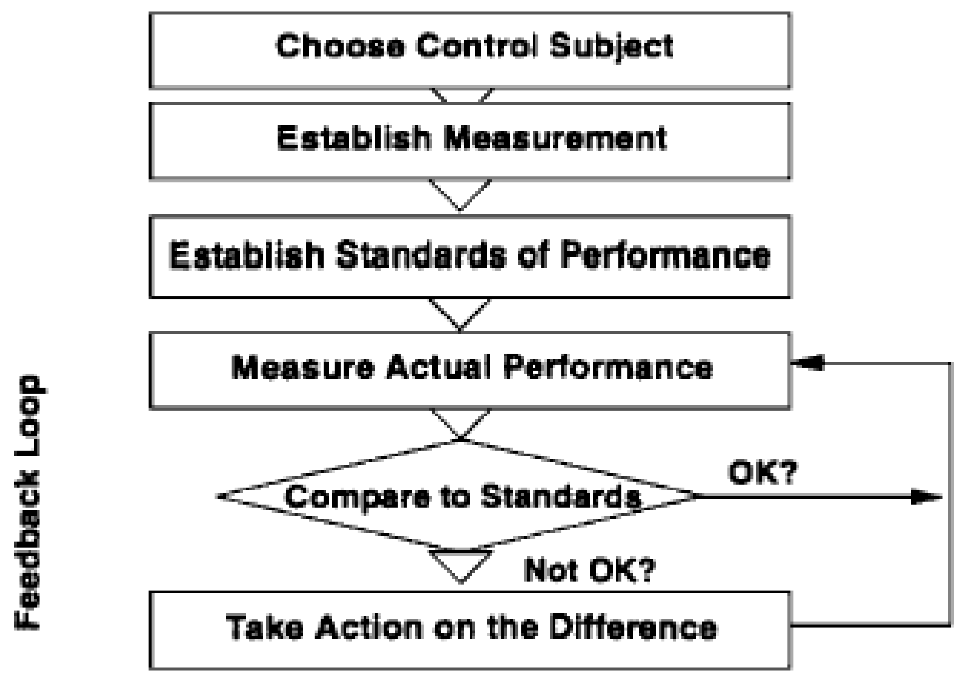

FIGURE 4.5 The quality control process. ("*Quality Control,*" *Leadership for the Quality Century, Juran Institute, Inc., senior executive workshop, p. 2, Wilton, CT.*)

Choose the Control Subject. Each feature of the product (goods and services) or process becomes a *control subject*—a center around which the feedback loop is built. The critical first step is to choose the control subject. Control subjects are derived from multiple sources which include:

- Stated customer needs for product features
- Technological analysis to translate customer needs into product and process features
- Process features which directly impact the product features
- Industry and government standards
- Needs to protect human safety and the environment
- Needs to avoid side effects such as irritations to employees or offense to the neighboring community

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TABLE 4.1 Examples of Control Subjects and Associated Quality Goals

Control subject	Goal
Vehicle mileage	Minimum of 25 mi/gal highway driving
Overnight delivery	99.5% delivered prior to 10:30 a.m. next morning
Reliability	Fewer than three failures in 25 years of service
Temperature	Minimum 505°F; maximum 515°F
Purchase-order error rate	No more than 3 errors/1000 purchase orders
Competitive performance	Equal or better than top three competitors on six factors
Customer satisfaction	90% or better rate, service outstanding or excellent
Customer retention	95% retention of key customers from year to year
Customer loyalty	100% of market share of over 80% of customers

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TABLE 4.2 Contrast of Quality Control at Two Levels—Work Force and Upper Management

	At work force levels	At managerial levels
Control goals	Product and process features in specifications and procedures	Business oriented, product salability, competitiveness
Sensors	Technological	Data systems
Decisions to be made	Conformance or not?	Meet customer needs or not?

Source: *Making Quality Happen,* Juran Institute, Inc., senior executive workshop, p. F-4, Wilton, Ct.

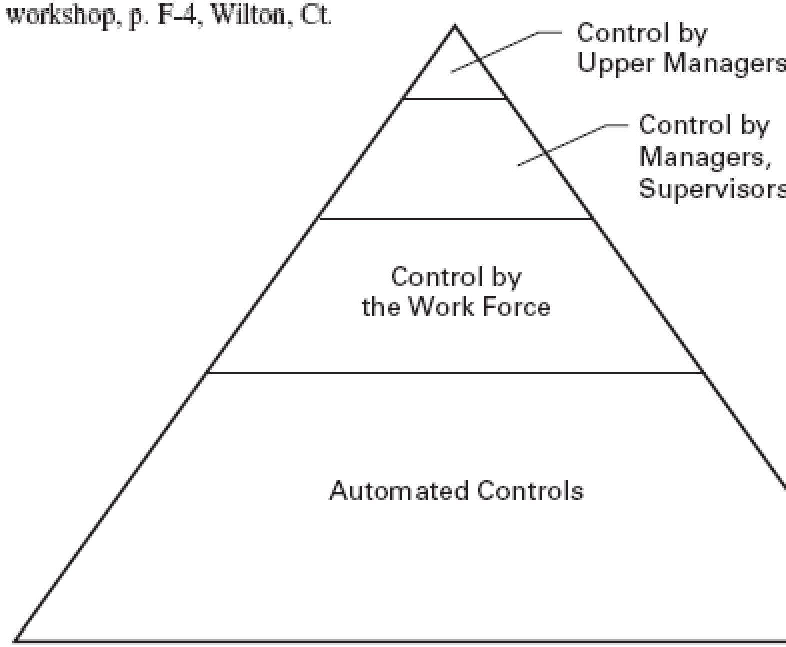

FIGURE 4.7 The pyramid of control. (*Making Quality Happen, Juran Institute, Inc., senior executive workshop, p. F-5, Wilton, CT.*)

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Control Stations. A "control station" is an area in which quality control takes place. In the lower levels of organization, a control station is usually confined to a limited physical area. Alternatively, the control station can take such forms as a patrol beat or a "control tower." At higher levels, control stations may be widely dispersed geographically, as is the scope of a manager's responsibility.

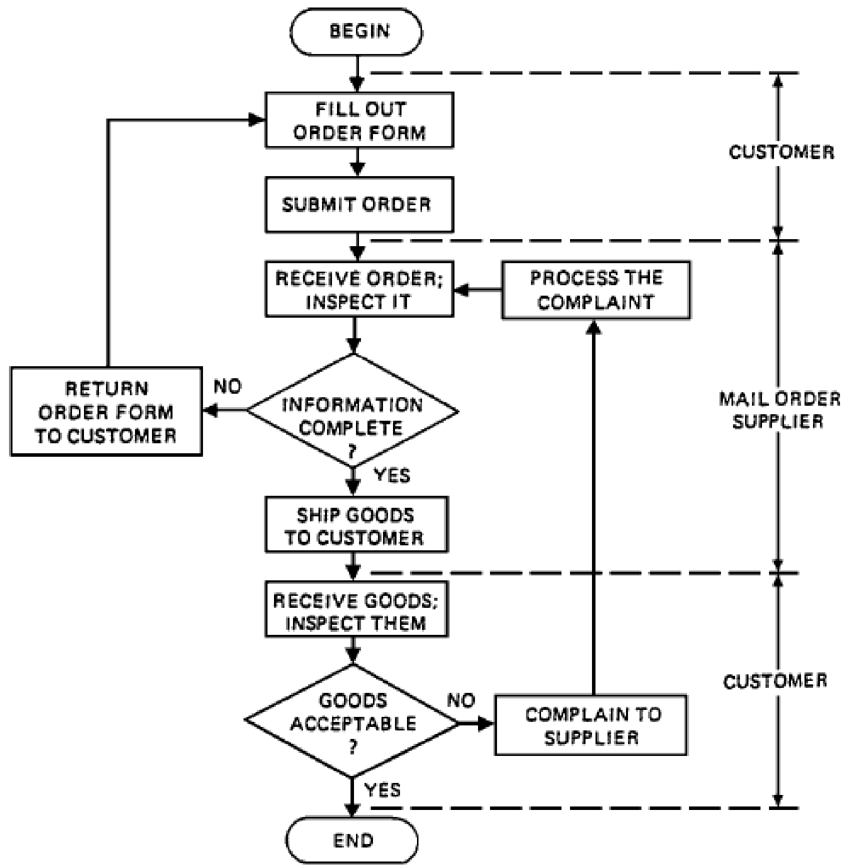

FIGURE 4.8 The flow diagram.

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Setup (Startup) Control. The end result of this form of control is the decision of whether or not to "push the start button."

Running Control. This form of control takes place periodically during the operation of the process. The purpose is to make the "run or stop" decision—whether the process should continue to produce product or whether it should stop.

Product Control. This form of control takes place after some amount of product has been produced. The purpose of the control is to decide whether or not the product conforms to the product quality goals. Assignment of responsibility for this decision differs from company to company. However, in all cases those who are to make the decision must be provided with the facilities and training which will enable them to understand the product quality goals, evaluate the actual product quality, and decide whether there is conformance.

Facilities Control. Most operating processes employ physical facilities: equipment, instruments, and tools. Increasingly the trend has been to use automated processes, computers, robots, etc. This same trend makes product quality more and more dependent on maintenance of the facilities.

Concept of Dominance. Control subjects are so numerous that planners are well advised to identify the vital few control subjects so that they will receive appropriate priority. One tool for identifying the vital few is the concept of dominance.

1. *Set-up dominant:* Some processes exhibit high stability and reproducibility of results, over many cycles of operation. A common example is the printing process. The design for control should provide the operating forces with the means for precise setup and validation before operations proceed.
2. *Time-dominant:* Here the process is known to change progressively with time, for example, depletion of consumable supplies, heating up, and wear of tools. The design for control should provide means for periodic evaluation of the effect of progressive change and for convenient readjustment.
3. *Component-dominant:* Here the main variable is the quality of the input materials and components. An example is the assembly of electronic or mechanical equipments. The design for control should be directed at supplier relations, including joint planning with suppliers to upgrade the quality of the inputs.
4. *Worker-dominant:* In these processes, quality depends mainly on the skill and knack possessed by the workers. The skilled trades are well-known examples. The design for control should emphasize aptitude testing of workers, training and certification, quality rating of workers, and error-proofing to reduce worker errors.
5. *Information-dominant:* Here the processes are of a "job-shop" nature, so that there is frequent change in what product is to be produced. As a result, the job information changes frequently. The design for control should concentrate on providing an information system which can deliver accurate, up-to-date information on just how this job differs from its predecessors.

Seriousness Classification. Another way of identifying the vital few control subjects is through "seriousness classification." Under this concept each product feature is classified into one of several defined classes such as critical, major, and minor. These classifications then guide the planners in allocation of resources, assignment of priorities, choice of facilities, frequency of inspection and test, etc.

Process Capability. One of the most important concepts in the quality planning process is "process capability." The prime application of this concept is during planning of the operating processes.

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PROCESS CONTROL FEATURES / CONTROL SUBJECT	UNIT OF MEASURE	TYPE OF SENSOR	GOAL	FREQUENCY OF MEASUREMENT	SAMPLE SIZE	CRITERIA FOR DECISION MAKING	RESPONSIBILITY FOR DECISION MAKING	• • •
Wave solder conditions Solder temperature	Degree F (°F)	Thermo-couple	505 °F	Continuous	N/A	510 °F reduce heat 500 °F increase heat	Operator	• • •
Conveyor speed	Feet per minute (ft/min)	ft/min	4.5 ft/min	1/hour	N/A	5 ft/min reduce speed 4 ft/min increase speed	Operator	• • •
Alloy purity	% Total contaminates	lab chemical analysis	1.5% max	1/month	15 grams	At 1.5%, drain bath, replace solder	Process engineer	• •
	• • •	• • •	• • •	• • •	• • •	• • •	• • •	

FIGURE 4.9 Spreadsheet for "Who does what?" (*Making Quality Happen, Juran Institute, Inc., senior executive workshop, p. F-8, Wilton, CT.*)

Process performance

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The Shewhart Control Chart. It is most desirable to provide umpires with tools which can help to distinguish between special causes and common causes. An elegant tool for this purpose is the Shewhart control chart (or just control chart) shown in Figure 4.10.

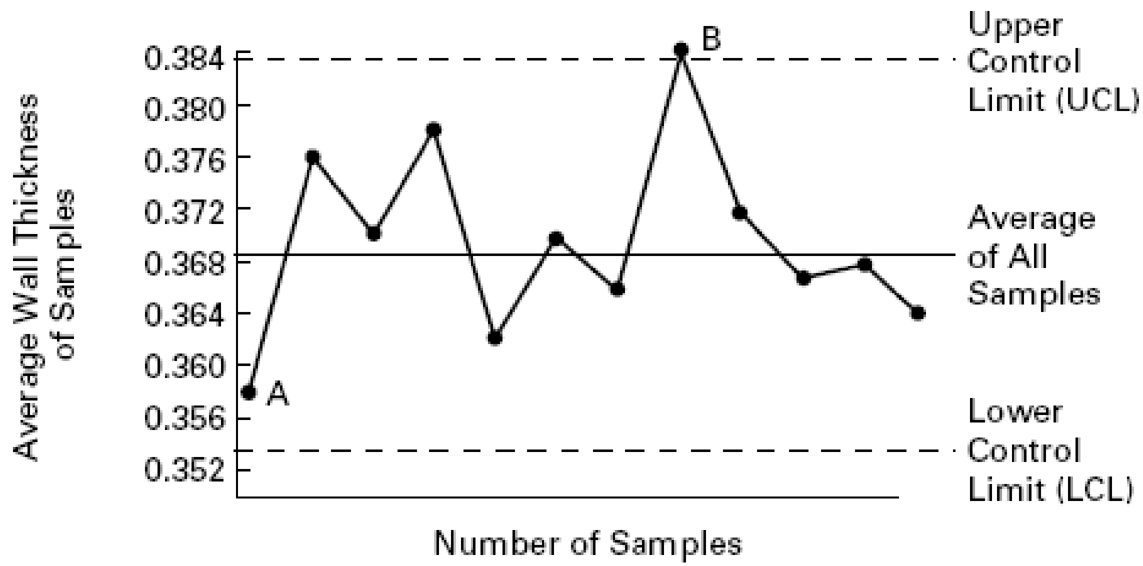

FIGURE 4.10 The Shewhart control chart. (*"Quality Control," Leadership for the Quality Century, Juran Institute, Inc., senior executive workshop, p. 4, Wilton, CT.*)

Points Within Control Limits. Point A on the chart differs from the historical average. However, since point A is within the limit lines, this difference could be due to common causes (at odds of less than 20 to 1.) Hence we assume that there is no special cause.

In the absence of special causes, the prevailing assumptions include:

Only common causes are present.

The process is in a state of "statistical control."

The process is doing the best it can.

The variations must be endured.

No action need be taken—taking action may make matters worse (a phenomenon known as "hunting" or "tampering."

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		PRODUCT	
		CONFORMS	DOES NOT CONFORM
PROCESS	DOES NOT CONFORM	B VAGUE	C CLEAR
PROCESS	CONFORMS	A CLEAR	D VAGUE

FIGURE 4.11 Example of areas of decision making. (*Making Quality Happen, Juran Institute, Inc., senior executive workshop, p.F-21, Wilton, CT.*)

The need for guidelines for decision making is evident from Figure 4.11. The guidelines for quadrants A and C are obvious. If both process and product conform to their respective goals, the process may continue to run. If neither process nor product conform to their respective goals, the process should be stopped, and remedial action should be taken. The guidelines for quadrants B and D are often vague, and this vagueness has been the source of a good deal of confusion. If the choice of action is delegated to the work force, the managers should establish clear guidelines.

TABLE 4.3 Multiple Delegations of Decision Making on Fitness for Use*

	Amount of product or money at stake is	
Effect of nonconformance is on	Small	Large
Internal economics only	Department head directly involved, quality engineer	Plant managers involved, quality manager
Economic relations with supplier	Supplier, purchasing agent, quality engineer	Supplier, manager
Economic relations with client	Client, salesperson, quality engineer	Client: for Marketing, Manufacturing, Technical, Quality
Field performance of the product	Product designer, salesperson, quality engineer	Client: managers for Technical, Manufacturing, Marketing Quality
Risk of damage to society or of nonconformance to government regulations	Product design manager, compliance officer, lawyer, quality managers	General manager and team of upper managers

*For those industries whose quality mission is really one of conformance to specification (for example, atomic energy, space), the real decision maker on fitness for use is the client or the government regulator.

تعاريف

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- *Process:* Set of interrelated resources and activities that transform inputs into outputs. [Note: Resources may include personnel, finance, facilities, equipment, techniques, and methods (ANSI/ISO/ASQC A8402-1994, clause 1.2).]
- *State of statistical control:* State in which the variations among the observed sampling results can be attributed to a system of chance causes that does not appear to change with time. [Note: Such a system of chance causes generally will behave as though the results are simple random samples from the same population) (ANSI/ISO/ASQC A3534-2-1993, clause 3.1.5).]
- *Process in control, stable process:* Process in which each of the quality measures (e.g., the average and variability or fraction nonconforming or average number of nonconformities of the product or service) is in a state of statistical control (ANSI/ISO/ASQC A3534-2-1993, clause 3.1.6).
- *Chance causes:* Factors, generally many in number but each of relatively small importance, contributing to variation that have not necessarily been identified. [Note: Chance causes are sometimes referred to as *common causes* of variation (ANSI/ISO/ASQC A3534-2-1993, clause 3.1.9).]
- *Assignable causes:* Factors (usually systematic) that can be detected and identified as contributing to a change in a quality characteristic or process level. [Notes: (1) Assignable causes are sometimes referred to as *special causes* of variation; (2) many small causes of change are assignable, but it may be uneconomic to consider or control them; in this case they should be treated as chance causes (ANSI/ISO/ASQC A3534-2-1993, clause 3.1.8).]
- *Control chart:* Chart with upper and/or lower control limits on which values of some statistical measure for a series of samples or subgroups are plotted, usually in time or sample number order. The chart frequently shows a central line to assist detection of a trend of plotted values toward either control limit. [Note: In some control charts, the control limits are based on the within-sample or within-subgroup data plotted on the chart; in others, the control limits are based on adopted standard or specified values applicable to the statistical measures being plotted on the chart (ANSI/ISO/ASQC A3534-2-1993, clause 3.3.1).]

اقدامات برای ایجاد نمودار کنترل

1. Choose the quality characteristic to be charted. In making this choice, there are several things to consider:
   a. Choose a characteristic that is currently experiencing a high number of nonconformities or items that do not conform. A Pareto analysis is useful to assist the process of making this choice.
   b. Identify the process variables contributing to the end-product characteristics to identify potential charting possibilities.
   c. Choose characteristics that will provide appropriate data to identify and diagnose problems. In choosing characteristics, it is important to remember that attributes provide summary data and may be used for any number of characteristics. On the other hand, variables data are used for only one characteristic on each chart but are necessary to diagnose problems and propose action on the characteristic.
   d. Determine a convenient point in the production process to locate the chart. This point should be early enough to prevent nonconformities and to guard against additional work on nonconforming items.

2. Choose the type of control chart.
   a. The first decision is whether to use a variables chart or an attributes chart. A variables chart is used to control individual measurable characteristics, whereas an attributes chart may be used with go no-go type of inspection. An attributes chart is used to control percentage or number of nonconforming items or number of nonconformities per item. A variables chart provides the maximum amount of information per item inspected. It is used to control both the level of the process and the variability of the process. An attributes chart often provides summary data that can be used to improve the process by then controlling individual characteristics.
   b. Choose the specific type of chart to be used. If a variables chart is to be used, decide whether the average and range or the average and standard deviation are to be charted. If small shifts in the mean are important, a cumulative sum or exponentially weighted moving average chart may be used. The disadvantage of these two latter charts is that they are more difficult for the practitioner to use and understand. If subgroups are not possible, individual readings may be used, but these are to be avoided if possible. For attributes charts, the percentage nonconforming or number of nonconforming items may be charted. In some cases, the number of nonconformities per inspection item may be preferable. All these charts will be discussed later.